# SOLVING COMPLEX MOTION PROBLEMS

The motion problems you have encountered to date are simple – you record the given information and solve for the desired unknown quantity. The question involves one object experiencing motion.

Often, two objects are experiencing motion simultaneously. For example, a police car is chasing a speedster. When and where will the police car catch up to the speeding vehicle? The answer to the question relies on your ability to analyze the motion of each vehicle separately. Each vehicle will have its own mathematical equation describing its motion. If each vehicle has a variable that is common to both, then this variable will enable you to then equate the equations and solve the problem. Take note that not all of the questions below fit this pattern – never the less, they require you to think about what is happening.

1. Caitlyn gives Michelle a 30 m head start in the 100 m dash. Caitlyn can run at 10 m/s while Michelle only runs at 6.0 m/s. Will Caitlyn catch up to Michelle? If so, when and where will this occur?

2. Toronto is about 50 km from Hamilton. A freight train starts out from Hamilton for Toronto at 50 km/h. At the same time, a passenger train leaves Toronto for Hamilton at 75 km/h. Assuming uniform motion, how much time passes before they meet one another, in minutes?

3. Alex runs out the door and starts down the road for school at 10 km/h. Six minutes later, his mother discovers that he has forgotten his lunch and runs after him at 14 km/h.
   a. How long does it take her to catch him, in seconds? [ 900 s ]
   b. How far from home is he when she catches him? [ 3.5 km ]

4. The Easter bunny runs along a straight and narrow path with a constant speed of 25 m/s. He passes a sleepy turtle, which immediately starts to chase the bunny with a constant acceleration of 0.003 $m/s^2$. How long does it take, in hours, for the turtle to catch up to the bunny? [ 4.63 h ]

5. The other day, at an intersection, the light turned green and I accelerated, from rest, at a rate of 1.8 $m/s^2$. At the same instant, a truck travelling with a constant speed of 8.5 m/s overtakes and passes me. How far did I travel before I caught up to the truck? How fast was I travelling at that moment? [80 m, 17 m/s]

6. This one involves only one object but it requires you to carefully think about what is happening. A turtle is moving with a constant acceleration along a straight path. He starts his "in shell" stopwatch as he passes a fence post and notes that it takes him 10 s to reach a pine tree 10 m farther along the straight path. As he passes the pine tree, his odometer tells him that he has a speed of 1.2 m/s. How far was he from the fence post when he began accelerating, assuming that he started from rest? [8.0 m]

7. Two trains, one travelling at 100 km/h and the other at 128 km/h, are headed towards one another on a straight and level track. When the trains are 1200 m apart, each engineer simultaneously sees the other and applies the brakes. Each train has a constant acceleration of -0.9 $m/s^2$. Will there be a collision? [NO]

8. Hmmm... A 60 meter race is run between a person who accelerates at 0.5 $m/s^2$ until he reaches a speed of 6 m/s and another who accelerates at 1 $m/s^2$ until reaching a speed of 4 m/s.
   a. Who wins the race AND by how much time? [ by 1 s ]
   b. How far from the finish line was the loser when the winner crossed it?